Agriculture

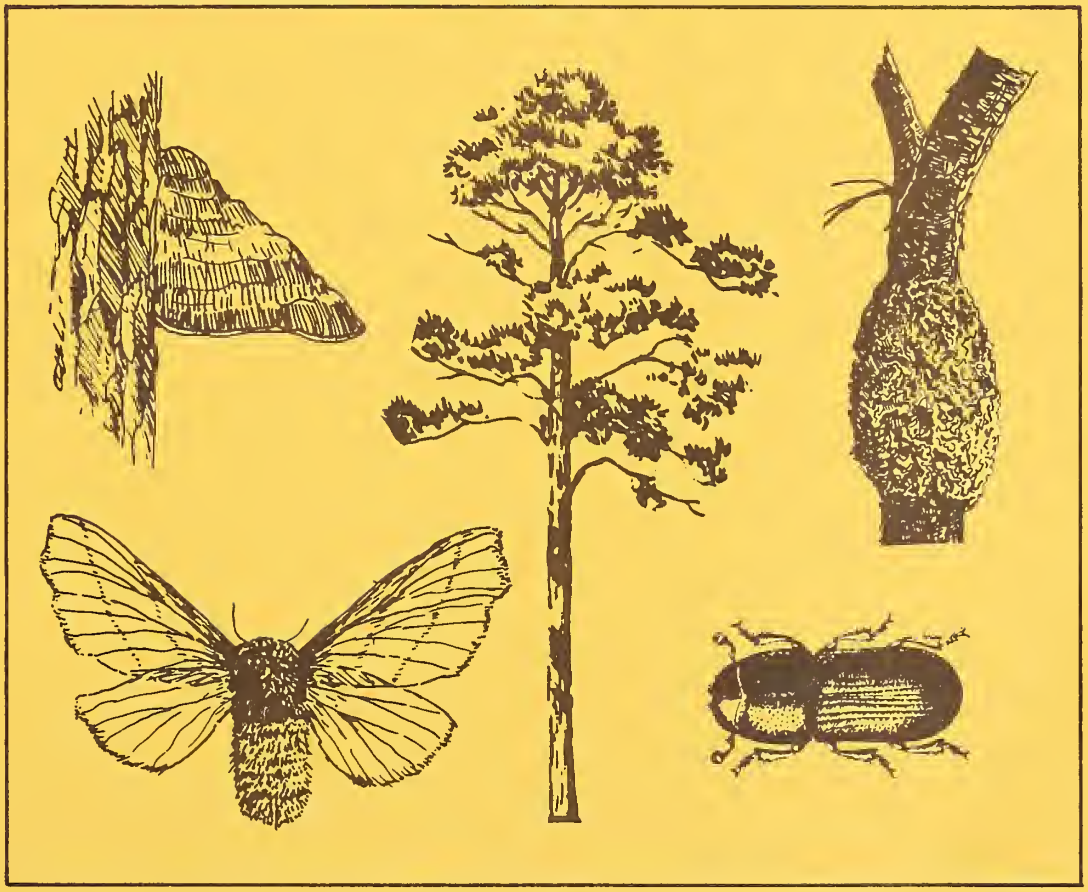
Forest Service
State & Private Forestry
Southeastern Area

Forest Pest Management

Forest Pest Management
Asheville Field Office

Report #85-1-11
June 1985

FINAL REPORT: 1980-1981 GUTHION-PYDRIN AERIAL APPLICATION PILOT STUDY



Jock Berry

Forest Pest Management
Asheville Field Office

Report #85-1-11
June 1985

FINAL REPORT: 1980-1981 GUTHION-PYDRIN AERIAL APPLICATION PILOT STUDY

Prepared by: Larry R. Barber
Entomologist

Donna S. Leonard
Biological Technician

Approved by: Harold W. Flake
for Harvey V. Toko
Staff Director
Forest Pest Management

ACKNOWLEDGEMENTS

The Asheville Field Office, Forest Pest Management, extends gratitude to individuals and their organizations who contributed to the success of this project:

Steve Dianis	Weyerhaeuser Co.	Washington, N.C.
Ed Sossaman	Weyerhaeuser Co.	Washington, N.C.
Gary Oppenheimer	Weyerhaeuser Co.	Washington, N.C.
Kirk Mlinek	Weyerhaeuser Co.	Washington, N.C.
Charles Lewis	Weyerhaeuser Co.	Washington, N.C.
Steve Ausbon	Weyerhaeuser Co.	Washington, N.C.
Marolyn Swindell	Weyerhaeuser Co.	Washington, N.C.
Jerry Jackson	Weyerhaeuser Co.	Washington, N.C.
Gary DeBarr	USDA Forest Service	Athens, Ga.
Mark Dalusky	USDA Forest Service	Asheville, N.C.
Mark Knect	USDA Forest Service	Asheville, N.C.
Jack Barry	USDA Forest Service	Davis, Ca.
Patricia Kenney	USDA Forest Service	Davis, Ca.
John Taylor	USDA Forest Service	Atlanta, Ga.
Don Widman	Nalco Chemical Co.	Leesburg, Fla.
Connie Garner	Mobay Chemical Corp.	Kansas City, Mo.
Gus Kurchoff	Shell Chemical Co.	Atlanta, Ga.

FINAL REPORT: 1980-1981 GUTHION-PYDRIN AERIAL APPLICATION PILOT STUDY

Larry R. Barber
Donna S. Leonard

ABSTRACT

During 1980 and 1981 a two year pilot project was undertaken at a Weyerhaeuser Seed Orchard near Washington, N.C. to demonstrate the efficacy of applying Guthion® and Pydrin® aerially for the control of seed and cone insects. The 1981 cone survival (4/80 through 9/81) in the untreated area was 13.7 percent as compared to 85.6 and 81.8 percent in Pydrin and Guthion areas, respectively. Overall seed orchard efficiency was 4.2 percent in the untreated block, as compared to 50.9 and 49.5 percent in the Pydrin and Guthion blocks. The Guthion and Pydrin treatment areas were significantly better than the untreated area for sound seed, healthy cones, flower to cone survival and overall seed orchard efficiency. There were no significant differences between either the Guthion or Pydrin treatments for these variables.

INTRODUCTION

Production of superior pine seed is of prime importance to the southern forest wood products industry. There are 10,000 acres of superior pine seed orchard trees, with over half currently in production. In 1981, these orchards produced record harvests; yet the seed produced is still not in sufficient quantity to meet the yearly nursery demand.

One of the primary reasons for this seed shortfall is cone and seed destruction by insects. Cone and seed insects on untreated orchards annually destroy up to 75 percent of the potential seed crop. In 1976, orchards began using Furadan® for insect control. With normal rainfall, Furadan, a granular systemic insecticide, provided adequate protection for most orchards. However, in 1978-1979, rainfall was reduced over previous years and many orchards reported increasing damage from coneworms (Dioryctria spp.). On some orchards, cone mortality exceeded 50 percent.

In an effort to reduce this damage, many orchard managers considered spraying Guthion via ground equipment. This, however, presented two serious drawbacks. First, workers would be exposed to a toxic insecticide, Guthion, for long periods of time while treating the orchards. In many cases, this would mean exposure for two or three weeks each month during the summer spray season. Second, most orchards were experiencing difficulties in obtaining good coverage on trees over 40 feet in height. In some cases, tree heights were in excess of 70 feet, and good spray coverage was often nearly impossible to obtain with the equipment present on orchards. To purchase adequate spray equipment would have required a large expenditure of money.

Jack Barry, National Pesticide Application Specialist, with USDA Forest Service, Methods Application Group (MAG), Davis, California, suggested that both of these problems encountered with ground application of Guthion could be overcome if application was by aircraft. He proposed a two-part plan to: 1) develop the technology base for aerial application of pesticides to southern pine seed orchards, and 2) to actually test Guthion applied by aircraft in seed orchards.

In 1978-1979, USDA Forest Service Research tested several new insecticides, and Pydrin showed in laboratory and preliminary field tests to be the most promising candidate. It was decided to include Pydrin in this test because of the relative safety advantages; i.e., low mammalian toxicity and favorable efficacy data.

In January 1980, Forest Pest Management entomologists, MAG, and others conducted an evaluation to determine the best strategies for applying pesticides to orchards. The results of this study indicated that aircraft could be as effective as ground sprayers and also offered suggestions for aircraft nozzle setup, speed, swath width, etc. (Barry et al., 1982). We also observed a slight improvement in coverage when a helicopter was used, as compared to a Stearman fixed-wing aircraft. Therefore, the decision was made to proceed with planning for the aerial application of Guthion and Pydrin to two orchards--one in Louisiana and one in North Carolina--using helicopters. This report documents the spray evaluation on the Weyerhaeuser Seed Orchard, Washington, N.C., April 1980 through October 1981.

OBJECTIVES

1. Obtain efficacy data on aerial application of Pydrin and Guthion.

2. Develop operational data on aerial application projects to support registration.

Names of principle insect species, description of their biologies and behavior, and damage caused (Ebel et al. 1975).

CONEWORMS *Dioryctria* spp.

The coneworm species are as follows: southern pine coneworm - *Dioryctria amatella* (Hulst.), blister coneworm - *D. clarioralis* (Walker), loblolly pine coneworm - *D. merkeli* Matuura & Monroe, and webbing coneworm - *D. disclusa* Heinrich

Biologies of coneworms are somewhat similar. Generally, these insects attack the flowers, buds, and shoots, as well as the conelets and cones. Damage consists of larval tunnels with partially to totally excavated areas within infested structures (Ebel et al. 1975).

Coneworms, depending on the species, have one to several generations a year. Young, first instar larvae overwinter and attack flowers and shoots the following spring. Later in the summer, cones are attacked. Some species, like D. amatella, infest fusiform rust, Cronartium fusiforme Hedge. & Hunt, galls and move to cones to complete their development. The webbing coneworm has one generation each year. The larvae first attack the developing male strobili in the spring and then move to the second year cones when the pollen catkins begin to dry and fall from the tree. Flowers are sometimes attacked.

SEEDBUGS, Leptoglossus corculus (Say) and Tetyra bipunctata (H.-S.)

These are sucking insects which feed upon developing conelets and seeds. Adults are strong fliers and nymphs are highly mobile, feeding on several conelets and cones during their life by puncturing them with their needle-like mouth parts. Early stages are gregarious and may kill conelets and cones. They also puncture developing seeds and destroy the endosperm, causing empty or partially developed seeds.

Leptoglossus corculus overwinters as an adult. Eggs are laid in rows on pine needles. Several generations occur each year. Nymphs or early stages are present from April through October, and adults can be found in spring, summer, and fall. In the deep South, the largest populations occur in July and August.

The shieldback bug, T. bipunctata, overwinters as an adult in the litter. This insect has one generation a year. Adult populations may become quite high in late summer and early fall.

METHODS AND MATERIALS

Site Description

In cooperation with Weyerhaeuser Company, the J. P. Weyerhaeuser Seed Orchard, near Washington, N.C., was selected for this evaluation. A 19-acre block of south coastal, low density, loblolly pine within the orchard was selected as the target area. The portion north of the orchard road was left untreated and used as a check area. The portion south of the road was divided in half--the western part being treated with Guthion and the eastern part with Pydrin (Fig. 1, schematic diagram of test area).

The orchard was established between 1963 and 1967. The trees were 40-50 feet tall in 1980. The rows are 30 feet apart; the trees within the rows are approximately 30 feet apart. Each of the treated areas contains 15 rows and covers 4.5 acres. The check area contains 30 rows and covers 10 acres.

Meteorological Measurements

A Climatronics Electronic Weather Station was used to measure and record wind direction, wind speed, temperature, and relative humidity. The vectorvane was mounted on top of a 50-foot pole in the center of the check area, which put it above the tops of surrounding trees. The recording portion was located on the same pole at a height of 5 feet above the ground. Refer to Figure 1 for a schematic diagram of the test area and the location of the weather station. Meteorological data recorded for each trial is provided in Table 1.

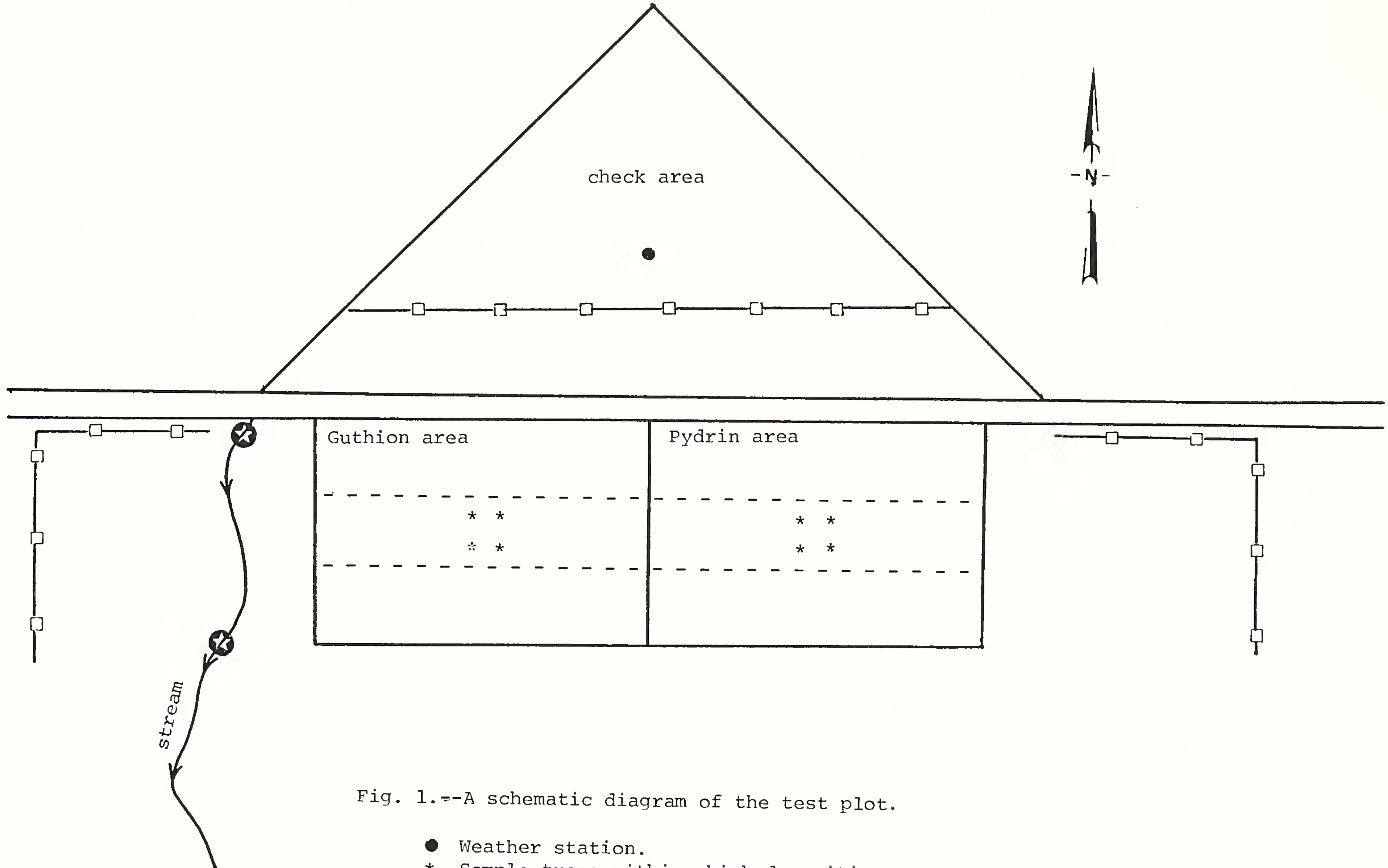


Fig. 1.--A schematic diagram of the test plot.

- ● Weather station.
- * Sample trees within which deposition measurements were made and from which needle samples were collected. Soil samples collected at the base of these trees.
- ✪ Water & sediment sample locations.
- \- - - - Ground sampling lines.
- □——□ Drift sampling line.

Table 1
WEATHER PARAMETERS FOR SPRAY INTERVALS1/

Weyerhaeuser Seed Orchard
Washington, N.C.
1980-81

Spray Date	Insecticide	Spray Time Start	Wind Direction	Wind Speed Initial	Wind Speed Final	Wind Speed Max	Humidity	Temp (°F)	Rainfall " (24 hour)
4/18/80	Guthion	6:15 am	S	1	1.5	2	2/	42	-
	Pydrin	8:10 am	S	2	6	8	2/	57	-
5/21/80	Guthion	7:50 pm	N	2	2	6	2/	75	3.23
	Pydrin	6:50 pm	NW	6	2	6	2/	78	3.23
6/17/80	Guthion	6:25 pm	E	2	3	3	61	75	0.4
	Pydrin	6:40 am	NE	2	5	6	74	63	-
7/15/80	Guthion	6:05 pm	SE	2	6	10	56	86	-
	Pydrin	5:25 pm	SE	3	3	7	44	88	-
8/12/80	Guthion	7:48 am	NW	2	5	7	88	77	-
	Pydrin	7:00 am	NW	3	6	7	91	76	-
9/11/80	Guthion	6:47 pm	S	4	1	6	51	77	-
	Pydrin	5:55 pm	S	2	5	5	43	80	-
4/16/81	Guthion	8:00 am	SE	4	5	8	71	52	-
	Pydrin	8:19 am	SE	5	3	6	60	53	-
5/13/81	Guthion	7:55 am	NE	4	6	6	90	57	-
	Pydrin	8:31 am	E	4	8	8	84	58	-
6/10/81	Guthion	6:25 am	SW	2	2	2	2/	76	-
	Pydrin	5:53 am	SW	2	2	2	2/	76	-
7/7/81	Guthion	5:42 am	NW	0	0	5	2/	71	-
	Pydrin	6:25 am	N	0	0	0	2/	72	-
8/7/81	Guthion	7:05 am	W	0	0	0	2/	71	-
	Pydrin	7:35 am	NW	0	0	0	2/	73	-
9/9/81	Guthion	6:30 am	N	0	0	0	2/	64	-
	Pydrin	7:18 am	N	0	0	0	2/	62	-

1/ Spraying time for each block in 1980 = $\pm$ 30 min.; 1981 = $\pm$ 8 min.

2/ Humidity function failure on weather station - data not available.

Application

A Bell Jet Ranger 207 helicopter, with a Simplex Wet Bucket Spraying System, was used for this project. Table 2 provides aircraft and application parameters.

Nalco Trol, a drift retardant adjuvant made by Nalco Chemical Co., was added to the tank mix in all but one of the spray applications. At the time of the first spray (4/18/80), Shell, the manufacturer of Pydrin, had not investigated the chemical or physical compatibility of Nalco Trol with Pydrin, so it was decided not to use Nalco Trol with the first Pydrin application. Prior to the second spray in May 1980, we were informed by Shell's research group that there were no incompatibility problems. Henceforth, Nalco Trol was used with every spray.

Rhodamine® Bx liquid dye was also added to the tank mix for all of the sprays in 1980, but discontinued in the spring of 1981. At this point, it was determined that enough spray deposition and impaction data had been collected.

Flight patterns for each year are illustrated in Figures 2 and 3. In 1980 the flight path was directly over the trees, the swath width was 30 feet and aircraft speed was 25 mph. In 1981 the flight path was directly over the row. The swath width was 60 feet and aircraft speed was 50 mph.

Spray Deposition Sampling

Sampling devices to obtain data on number of spray droplets and spray volume were positioned in the upper 10 feet of the tree crown of 8 sample trees--4 in the center of each sprayed area. Figure 4 is a schematic diagram of a spray deposition sample tree. Sampling devices consisted of soft drink cans covered with Kromekote® paper. The Kromekote paper was assessed by the Quantimet for number and size of droplets and to estimate volume. The latter was accomplished on the USDA Forest Service Automatic Spot Counting and Sizing Computer Program (ASCAS) in Davis, Calif.

Ground level spray deposition measurements, for the purpose of calculating canopy penetration, were made by placing rows of Kromekote cards attached to cardboard holders with rubberbands on the floor of the orchard. Ground sampling lines ran perpendicular to orchard rows and to the path of the helicopter during spray applications. The ground lines were located 150 feet and 300 feet into the orchard, south from the road, in each of the treated areas and extended for 400 feet each. The ground cards were placed at intervals of 10 feet along these sampling lines, for a total of 40 cards on each of the 4 ground sampling lines. Refer to Figure 1 for a schematic diagram of the ground sampling lines within the test area.

A drift sampling line was also located several hundred feet outside the perimeter of the treatment areas for the purpose of measuring spray drift. The cards were placed at intervals of 90 feet along this line. Every third card placement spot also had a cylindrical sampler mounted on a 3-foot stake. Refer to Figure 1 for a schematic diagram of the sampling line in and around the test area.

Table 2
Aircraft and Application Parameters
Weyerhaeuser Seed Orchard, Washington, N.C.
1980-81

Parameter	1980	1981
Aircraft	Bell Jet Ranger 207	Bell Jet Ranger 207
Delivery system	Simplex Wet Bucket System	Simplex Wet Bucket System
Swath width	30'	60'
Speed	25 mph	50 mph
Boom pressure	40 PSI	43 PSI
Nozzle type 1/	D2-25	D5-45
No. of nozzles	50	60
Nozzle orientation	Straight back	12 straight back, other 48 straight down
Application rate	10 gal/acre	10 gal/acre
Active Ingredient/Acre	Guthion: 3 lbs. AI/AC Pydrin: .75 lbs. AI/AC	Guthion: 3 lbs. AI/AC Pydrin: .75 lbs. AI/AC
Per 55 gallon tank mix		
Rhodamine Bx liquid dye	2 pints	none 2/
Nalco Trol	2.75 oz. 3/	.66 oz.
Insecticide	Guthion 2S: 8.25 gal. Pydrin: 1.73 gal.	Guthion 2F: 8.25 gal. Pydrin: 1.73 gal.

1/ Manufactured by Spraying Systems Co.

2/ Rhodamine added to both Pydrin and Guthion tank mixes for the first spray in 1981 (April 16, 1981) at the rate of 2 oz/55 gallons of tank mix.

3/ No Nalco Trol added to the Pydrin tank mix for the first spray (April 18, 1980).

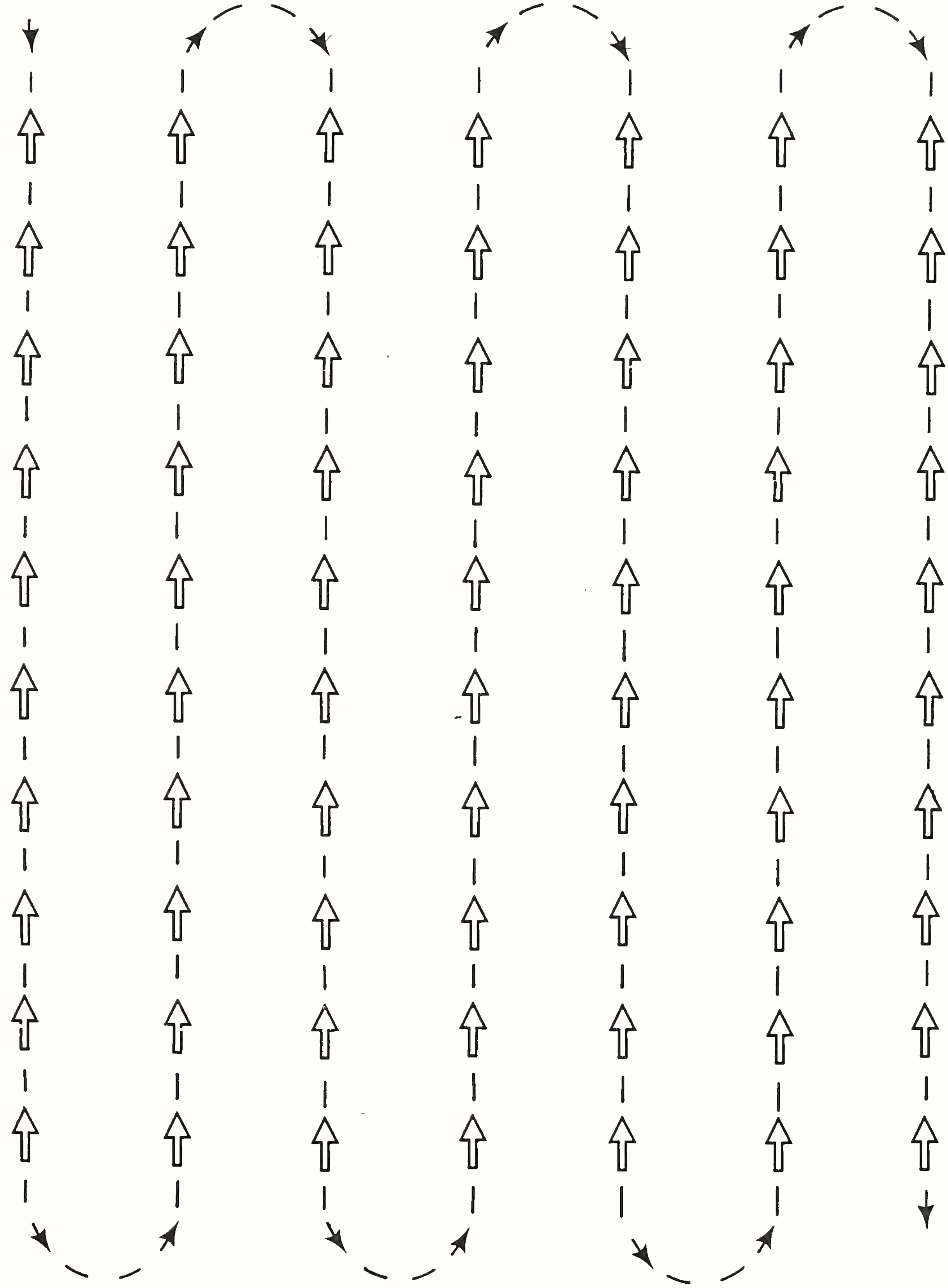


Figure 2.--1980 Flight Pattern - swath width 30', helicopter flight path directly over trees. Aircraft was calibrated at 5 gal. per acre. Two passes were made over each row for a total of 10 gal. per acre.

Helicopter Flight Path

Orchard Trees

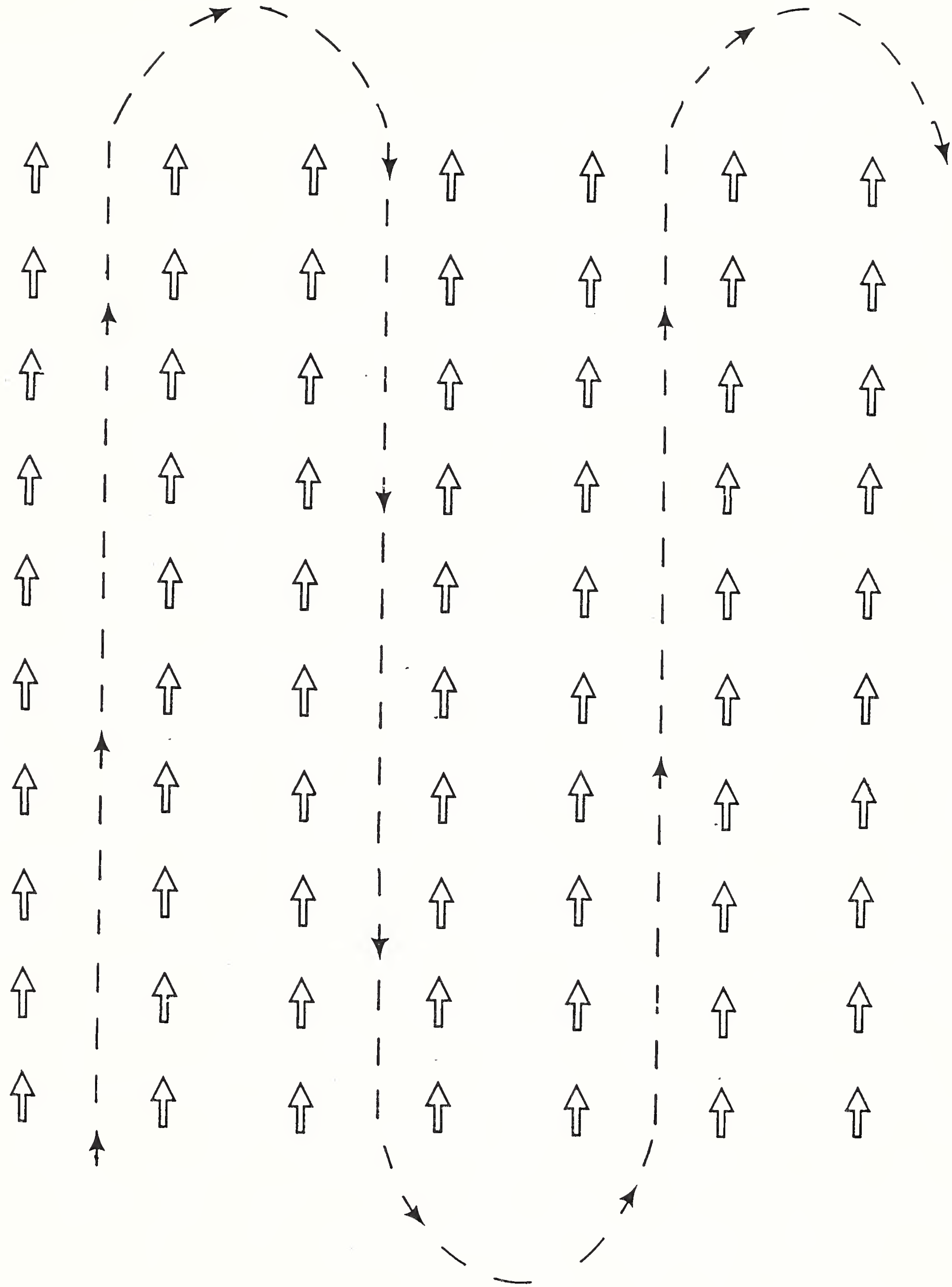


Figure 3.--1981 Flight Pattern - swath width 60', helicopter flight path directly over center of every other row. Aircraft was calibrated at 5 gal. per acre. Two passes were made over the center of every other row for a total of 10 gal. per acre.

Helicopter Flight Path

Orchard Trees

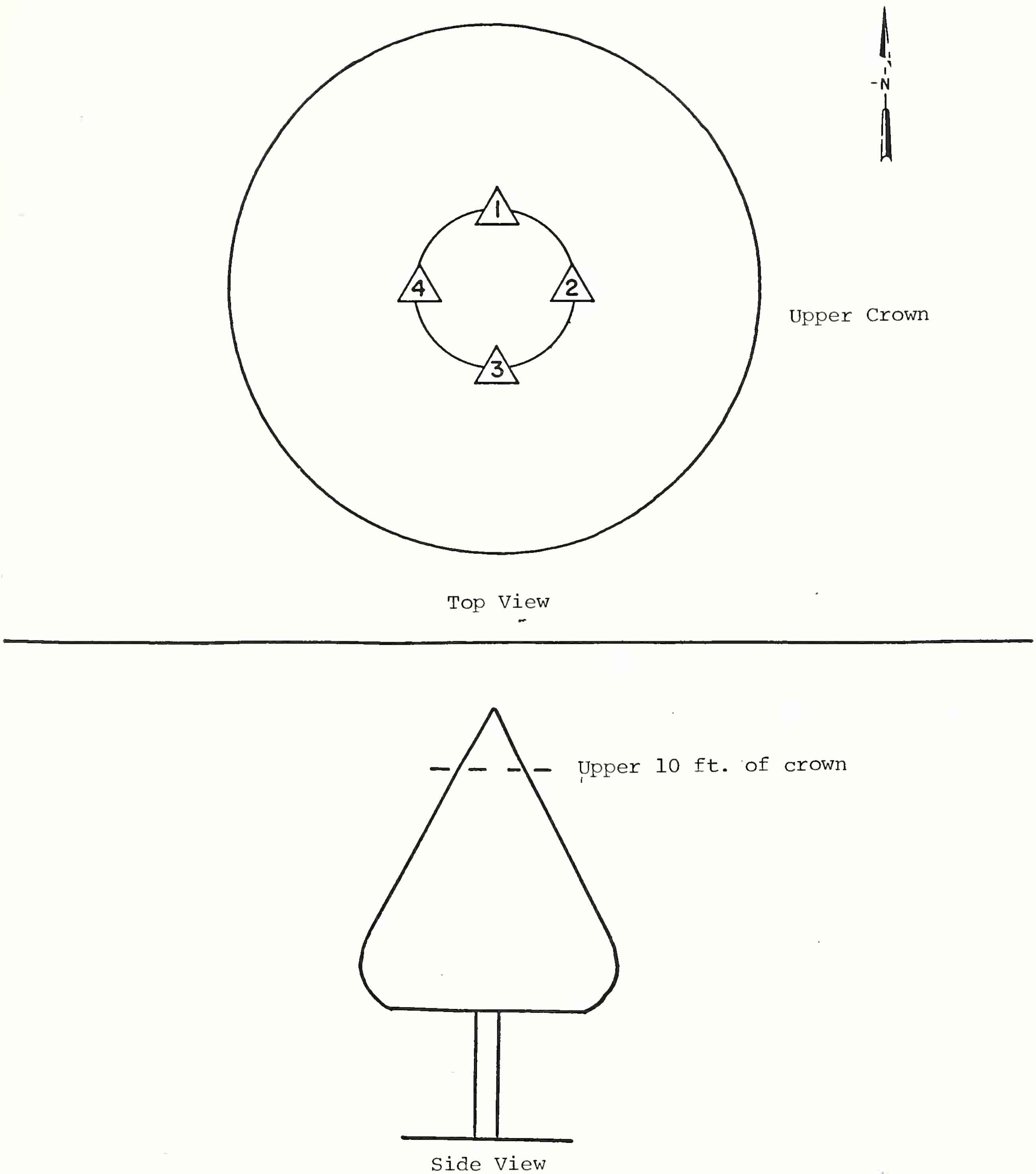


Figure 4.--Schematic diagram of cylindrical sampling in designated sample trees.

Pesticide Residue Sampling

Needle, soil, water, and sediment samples were collected immediately after each spray so that pesticide residue levels in and around the test area could be monitored. Needle samples were collected from the top one-third of the crown of the same trees that were used for spray deposition sampling, wrapped in tin foil, and placed in an airtight plastic ziploc bag. Soil samples were collected at the base of these same trees--one sample from within the row and the second sample from between the rows. Soil samples were collected with an acetone rinsed spade and placed in acetone rinsed quart jars.

Water and sediment samples were collected immediately following a spray, then again 24 hours after application. One sample point was established where the drainage entered the test area and the other where the drainage left the test area. Water and sediment samples were collected in one quart jars that had been rinsed with acetone. Refer to Figure 1 for the locations of all residue sampling locations within and around the test area.

Needle and soil samples were stored frozen; water and sediment samples were stored at 35°F until all samples could be shipped to the S.C. Dept. of Health and Environmental Control, Columbia, S.C. for analysis.

Cone and Seed Damage Sampling

Seven of the most coneworm-susceptible, cone-producing clones were selected for sampling. Two ramets of each of these clones were selected in each treatment area; i.e., Pydrin, Guthion, and check, for a total of 41 sample trees (Table 3). There was only one ramet of clone 9-9 in the Guthion test area; therefore, only 41 trees. In April 1980, a minimum of 10 percent of the flower and pre-existing cone crops in these trees were tagged and recorded on data sheets (Fig. 5). The pre-existing cones were monitored through their harvest in September 1980, a total of six months. The tagged flowers were monitored periodically until their maturity as the 1981 cone crop in September 1981. In April 1981, that year's flower crop was also tagged and monitored through the completion of the study (Sept. 1981).

The data sheets were designed to allow the condition of each tagged flower or cone to be recorded and carried through its entire life cycle. These data were later developed into life tables that show the cause and approximate time of cone and flower mortality.

The tagged flowers and cones were observed monthly in the check area where seed and cone insect activity was greatest. The tagged flowers and cones on sample trees in the Pydrin and Guthion treated areas were only checked when cone damage reached significant levels in the untreated area.

In the fall of both years, when the cones were ripe, six healthy cones were collected from each of the 41 tagged trees that still had cones available. These cones were bagged, labeled, and sent to the National Tree Seed Lab in Macon, Ga., for seed extraction, radiography, and CAS analysis (Bramlett et al., 1977). This consists of an indepth analysis of seed potential of the cones, number of first and second year aborted ovules, number of sound, empty, and malformed seed, and number of seedbug and seedworm damaged seed.

Table 3.--List of ramets included in 1980-81 aerial pilot project, Weyerhaeuser Seed Orchard, Washington, N.C.

Clone	Control Location (Row, Hill)	Pydrin Location (Row, Hill)	Guthion Location (Row, Hill)
8-136	R25, H27	R3, H10	R21, H30
	R17, H22	R3, H5	R21, H24
8-191	R27, H26 R	R3, H31	R24, H26
	R39, H33 R	R6, H5	R24, H7
8-144	R18, H23	R2, H25	R23, H3
	R22, H21	R2, H13	R21, H25
7-70	R25, H35	R5, H1	R20, H21
	R18, H25	R6, H8	R19, H24
9-15	R31, H18	R2, H18	R18, H29
	R24, H20	R2, H5	R19, H7
8-104	R29, H16	R7, H21	R20, H28
	R22, H30	R7, H27	R19, H4
9-9	R37, H35	R4, H22	R16, H18
	R33, H20	R6, H2	

Ramet Location ____________________ Insecticide ____________________

Flower Year ____________________ Rate ____________________

Orchard ____

Date							
St.	#	cond/code	cond/code	cond/code	cond/code	cond/code	cond/code

Condition

1. healthy
2. dead
3. distorted-malformed
4. infested
5. other

Code

10. *Dioryctria* spp.
11. *Eucosma* spp.
12. *Conophthorus* spp.
13. thrips
14. tip moth
15. aborted
16. disease
17. unknown or missing
18. mechanical
19. *Dioryctria disclusa*

Figure 5.

RESULTS

1980

Cone Mortality

Webbing coneworm damage was extensive in the untreated area, where 90.6 percent of the crop was destroyed (Table 4). This damage was the result of a *D. disclusa* infestation, which began April 23. Webbing coneworm damage was 14.1 and 1.7 percent in the Pydrin and Guthion treated areas, respectively. Mortality in the untreated area was significantly different from the treated areas at the 1 percent level; however, the Pydrin and Guthion areas were not significantly different from each other.

Damage from other coneworms; i.e., *D. amatella*, *D. clarioralis*, and *D. merkeli*, was 1.7 percent in the untreated area, while in the Guthion and Pydrin areas it was 5 and 11.9 percent, respectively. Few healthy cones remained in the untreated area after the *D. disclusa* infestation, thus the depression in percent of other coneworm attacks in the untreated area.

Flower and Conelet Mortality

First year conelet mortality, caused by *D. disclusa*, was 24.7 percent in the untreated area compared to no mortality (0) in the two treated areas (Table 4). This was significantly different at the 1 percent level. The treated areas did not differ from each other.

Seed Analysis

Because of the April 1980 *D. disclusa* outbreak, only clone 7-70 (apparently resistant to *D. disclusa* attack) in the untreated area produced six healthy cones at fall harvest. In the treated areas, all clones produced at least six healthy cones.

The data from the CAS analysis is presented in Table 5; however, because of the missing data (no cones) in the untreated area, no statistical analysis was performed on this data set.

Weather Data

Detailed meteorological data was collected at the time of each spray and is documented in Table 1. Sprays were generally conducted with wind speeds of less than 7 mph. On three occurrences, April 18, July 15, and August 12, a portion of each spray was applied at speeds of 7 mph or greater. The maximum wind recorded during a spray was on July 15, when a gust was documented at 10 mph. In this case, when the Guthion spray was initiated at 6:05 p.m., the wind was 2 mph. At the conclusion of this spray, the wind was 6 mph.

On only two spray dates was measurable rainfall recorded within 24 hours of the application. After the May 21 spray, 3.23 inches of rainfall were recorded and .4 inch was documented after the June application.

Table 4
AERIAL APPLICATION PILOT STUDY DATA SUMMARY
Cone and Conelet Mortality
Washington, N.C.

Data computed from observations March 1980 through September 1980

Structure	Treatment	Percent Healthy	Webbing Coneworm	Other Coneworm	Other	Malformed
Cones	Untreated	7.2 a 3/	90.6 a 3/	1.7 a 3/	0.5 a 3/	-
	Pydrin 1/	63.1 b	14.1 b	11.9 b	10.9 a	-
	Guthion 2/	78.5 b	1.7 b	5.0 ab	14.8 a	-
Conelets	Untreated	53.9 a	24.7 a	0.5 a	15.9 a	-
	Pydrin	86.9 b	0.0 b	0.0 a	13.1 a	-
	Guthion	83.5 b	0.0 b	0.0 a	16.5 a	-

Data computed from observations March 1981 through September 1981

Structure	Treatment	Healthy	Webbing Coneworm	Other Coneworm	Other	Malformed
Cones	Untreated	23.9 4/	66.0 4/	6.7 4/	2.3 4/	1.1 4/
	Pydrin	95.9	-	1.0	2.1	1.0
	Guthion	95.7	-	1.7	2.2	0.2
Conelets	Untreated	80.4 a 3/	6.3 a 3/	.8 4/	12.5 4/	-
	Pydrin	89.8 b	- b	.2	10.0	-
	Guthion	87.0 b	- b	-	13.0	-

1/ Applied 6 times at monthly intervals at .75 lbs. AI/AC.

2/ Applied 6 times at monthly intervals at 3 lbs. AI/AC.

3/ Treatment means followed by the same letter are not significantly different at the 1 percent level.

4/ These data not analyzed.

Table 5
1980 Loblolly Pine Cone Crop
Weyerhaeuser Seed Orchard, Washington, N.C.

SEED ANALYSIS

Treatment	Clone	1st yr. Abort.[1/]	2nd yr. Abort.	Insect Damage	Empty Seed	Sound Seed	Misc.
Guthion	8-136	74.9	0	0.1	6.7	136.3	0.8
	7-70	27.8	0	0	6.4	134.5	0.2
	8-104	73.8	0	0	4.9	110.8	0.8
	8-191	72.6	0	0	22.2	110.0	2.6
	8-144	61.8	0	0	13.4	108.7	12.5
	9-15	78.8	0	0.3	16.1	114.5	3.5
	9-9	77.0	0	0.2	8.8	75.2	1.5
Pydrin	8-136	53.6	0	0.1	11.3	112.4	0.9
	7-70	38.7	0	0.1	4.4	129.7	0.8
	8-104	22.2	0	0.1	6.9	147.2	0.7
	8-191	40.9	0	0	4.2	150.0	3.1
	8-144	43.2	0	0.1	16.8	127.6	7.3
	9-15	75.5	0	0.2	13.8	109.0	1.5
	9-9	34.9	0	0	4.8	130.8	1.5
Untreated[2/]	7-70	49.1	2.3	0.5	16.6	93.3	0.8

1/ Average number of seed per cone from a 12 cone sample from 2 ramets of each clone - 6 cones from each ramet.

2/ All clones, except one, lost all cones to insect damage in the untreated area.

Spray Assessment

Droplet size on the ground line (Mass Median Diameter [MMD]) during 1980 ranged from 381.9 um to 447.7 um in the Guthion area (Table 6). In the Pydrin treated area the MMD ranged from 294.8 um to 339.3 um. Drops deposited per cm^2 ranged from 46.69 to 75.87 in the Guthion area as compared to a range of 33.06 to 99.88 in the Pydrin area. Penetration of the spray to the ground measured in gallons per acre ranged from 3.9 to 9.3 gallons in the Guthion area as compared to 3.0 to 7.1 gallons in the Pydrin area.

The average MMD for all spray trials of drops reaching the orchard floor was larger in the Guthion area than in the Pydrin area; i.e., 408.5 um vs 313.4 um. Drops per cm^2 were quite similar between the Pydrin and Guthion treated areas at 55.42 and 58.61, respectively. The average amount of spray falling to the orchard floor was 4.51 gallons in the Pydrin area as compared to 5.97 gallons in the Guthion plot.

Drift cards on the ground had an average MMD of 537.7 and 370.7 following the Guthion and Pydrin sprays, respectively. Drops deposited on the drift cards per cm^2 were 0.63 following the Guthion treatment as compared to 1.32 with the Pydrin treatment. The amount of pesticide recovered on the drift cards surrounding the treatment blocks was .03 gallon for the Guthion treatment and .06 gallon for Pydrin.

Pesticide Monitoring

Pydrin residues on the needles ranged from 29.0 ppm to 41.9 ppm (Table 7). Soil residue samples in the tree row with duff removed ranged from none to .022 ppm of Guthion and a trace to 32.0 ppb of Pydrin. Soil residue samples between rows with the duff removed ranged from none to .033 ppm of Guthion while in the Pydrin area we detected a trace to 183 ppb. No residue of Pydrin or Guthion was detected in any of the water or sediment samples collected during 1980, except for a water sample collected 5/21/80. In this sample, 3.5 ppb of Guthion was detected.

RESULTS

1981

Cone Mortality

Cone mortality from webbing coneworm infestations in 1981 was 66 percent in the untreated area with no damage detected in either treated area. Cone mortality from coneworms other than *D. disclusa* was 6.7 percent in the untreated area as compared to 1 and 1.7 percent in the Pydrin and Guthion treatment blocks.

Flower and Conelet Mortality

In 1981 the webbing coneworm destroyed 6.3 percent of the flower crop in the untreated area while no damage was detected in the treated blocks. The treated areas were not different from one another but were different from the untreated area at the 1 percent level.

Table 6
Spray Deposit Data Applied to
Weyerhaeuser Seed Orchard by
Bell Jet Ranger at 10 gal/AC
1980

			Ground Lines			Avg. Tree Samplers			Drift Cards		
Insecticide	Trial	Date	MMD (um)[1/]	Drops/cm^2	Gal/AC	MMD (um)	Drops/cm^2	Gal/AC	MMD (um)	Drops/cm^2	Gal/AC
Guthion	1	4/18/80	447.7	75.87	9.26	357.7	54.90	3.88	462.0	1.27	.01
	2	5/21/80	387.1	63.51	5.17	516.0	91.61	12.90	529.3	.16	.03
	3	6/17/80	381.9	46.69	3.90	444.2	44.72	5.77	621.9	0.47	.06
	6	9/11/80	417.3	48.37	5.53	-	-	-	-	-	-
		$\overline{x}$	408.5	58.61	5.97	439.3	63.74	7.51	537.7	0.63	.03
Pydrin	1	4/18/80	339.3	33.06	4.02	350.3	40.80	4.59	344.7	1.20	.11
	2	5/21/80	299.1	99.88	7.09	318.4	72.77	5.66	-	-	-
	3	6/17/80	294.8	55.10	3.91	322.7	61.97	4.70	392.4	.09	.03
	6	9/11/80	320.3	33.64	3.02	-	-	-	374.9	2.68	.03
		$\overline{x}$	313.4	55.42	4.51	330.5	58.51	4.98	370.7	1.32	.06

1/ Mass Median Diameter

Table 7
Pesticide Monitoring Data
Weyerhaeuser Seed Orchard
1980-1981

Trial #	Spray Date	Date Sample Collected	Needle Samples: Pydrin	Needle Samples: Guthion	Soil Samples: Guthion within row	Soil Samples: Guthion between row	Soil Samples: Pydrin within row	Soil Samples: Pydrin between row	Drainage Entrance to Test Area: water	Drainage Entrance to Test Area: sediment	Drainage Entrance to Test Area: water at 24 hrs.	Drainage Exit from Test Area: water	Drainage Exit from Test Area: sediment	Drainage Exit from Test Area: water at 24 hrs.
1	4/18/80	4/18/80	29.7 ppm	NA	T G	.033 ppm G	T P	T P	ND 1/	ND	-	ND	ND	-
2	5/21/80	5/22/80	36.0 ppm	NA	ND	ND	20.2 ppb P	T	3.5 ppb G	ND	-	ND	ND	-
3	6/17/80	6/17/80	34.2 ppm	NA	.022 ppm G	ND	T P	T P	NW	ND	NW	NW	ND	NW
4	7/15/80	7/15/80	41.9 ppm	NA	.012 ppm G	ND	22.6 ppb P	T	NW	ND	NW	NW	ND	NW
5	8/12/80	8/12/80	29.08 ppm	NA	.008 ppm G	.006 ppm G	32.0 ppb P	183 ppb P	NW	ND	NW	NW	ND	NW
6	9/11/80	N O D A T A C O L L E C T E D												
7	4/16/81	4/16/81	22.8 ppm	194.0 ppm	.13 ppm G	.32 ppm G	ND	ND	T-P 36.0 ppb G	QNS	ND-P <0.3 ppb G	T-P 98 ppb G	ND	ND-P 4.2 ppb G
8	5/13/81	5/13/81	352.8 ppm	80.0 ppm	.024 ppm G	.024 ppm G	ND	ND	ND	QNS	ND-P <0.6 ppb G		ND	T-P <0.5 ppb G
9	6/10/81	6/10/81	N O S A M P L E S		.032 ppm G	<.02 ppm G	ND	ND	ND-P .37 ppb G	ND	ND-P 3 ppb G	ND-P <0.8 ppb G	ND	ND-P 2.7 ppb G
10	7/7/81	7/7/81	37.5 ppm	66.0 ppm	.73 ppm G	.013 ppm G	ND	ND	ND-P 0.58 ppb G	ND	ND-P 0.64 ppb G	ND-P >0.9 ppb G	T P	ND-P >0.8 ppb G
11	8/7/81	N O D A T A C O L L E C T E D												
12	9/9/81	N O D A T A C O L L E C T E D												

1/ ND = none detected, T = trace (< 20 ppb), G = Guthion, P = Pydrin, NW = no water in ditch, NA = samples not analyzed, QNS = quantity not sufficient

Cone Crop Life Table

Life tables provide a means of determining the month or strobili development stage which receives the most serious damage (DeBarr and Barber 1975). In this stage the cause(s) of the damage can be categorized and its importance determined.

In Table 8 and Figure 6, life tables are presented for the 1981 cone crop when left untreated or treated with Pydrin or Guthion. Beginning with a sample size of 2,232 flowers in the untreated area in April 1980 only 305 survived to maturity at harvest, representing only 13.7 percent of the initial crop. The trees treated with Pydrin had a sample flower crop size of 2,078 at the beginning of the study and 1,778 cones at harvest or a flower to cone survival of 85.6 percent. This compares to the Guthion treated trees where 2,055 flowers were tagged and 1,680 cones were harvested (81.8 percent).

The webbing coneworm was the primary damaging agent to the 1981 cone crop. This insect caused 24.9 percent mortality to the flower stage (1980) and 37.8 percent mortality to the cone stage (1981) in the untreated area. Little or no damage was documented in the chemically treated areas.

Seed Analysis

Analysis (CAS) of the 1981 seed documented only 30.8 percent sound seed in the untreated area as compared to 60.6 and 59.5 percent in the Guthion and Pydrin treated areas (Table 9). First year aborted ovules were 46.3 percent in the untreated area while in the Pydrin and Guthion areas they were 30.3 and 30.7 percent, respectively. There was no (0) second year aborted damage detected in the Pydrin cones and only 0.9 percent in the Guthion treated cones. This compares to 7.3 percent in cones in the untreated block. For the above categories; i.e., sound seed, first year aborted seed and second year aborted seed, the untreated seed were significantly different from the treated seed at the 1 percent level. There was no difference between the two pesticide treated seedlots.

Weather Data

As in 1980, sprays were generally conducted with wind speeds of less than 7 mph (Table 1). On two occasions (April 16 & May 13) the maximum wind speed exceeded 7 mph.

The Climatronics Electronic Weather Station was inoperable for the last three months of the project, consequently temperature is the only weather data available for the July, August and September 1981 sprays.

There was no measurable rainfall recorded within 24 hours of any of the spray dates.

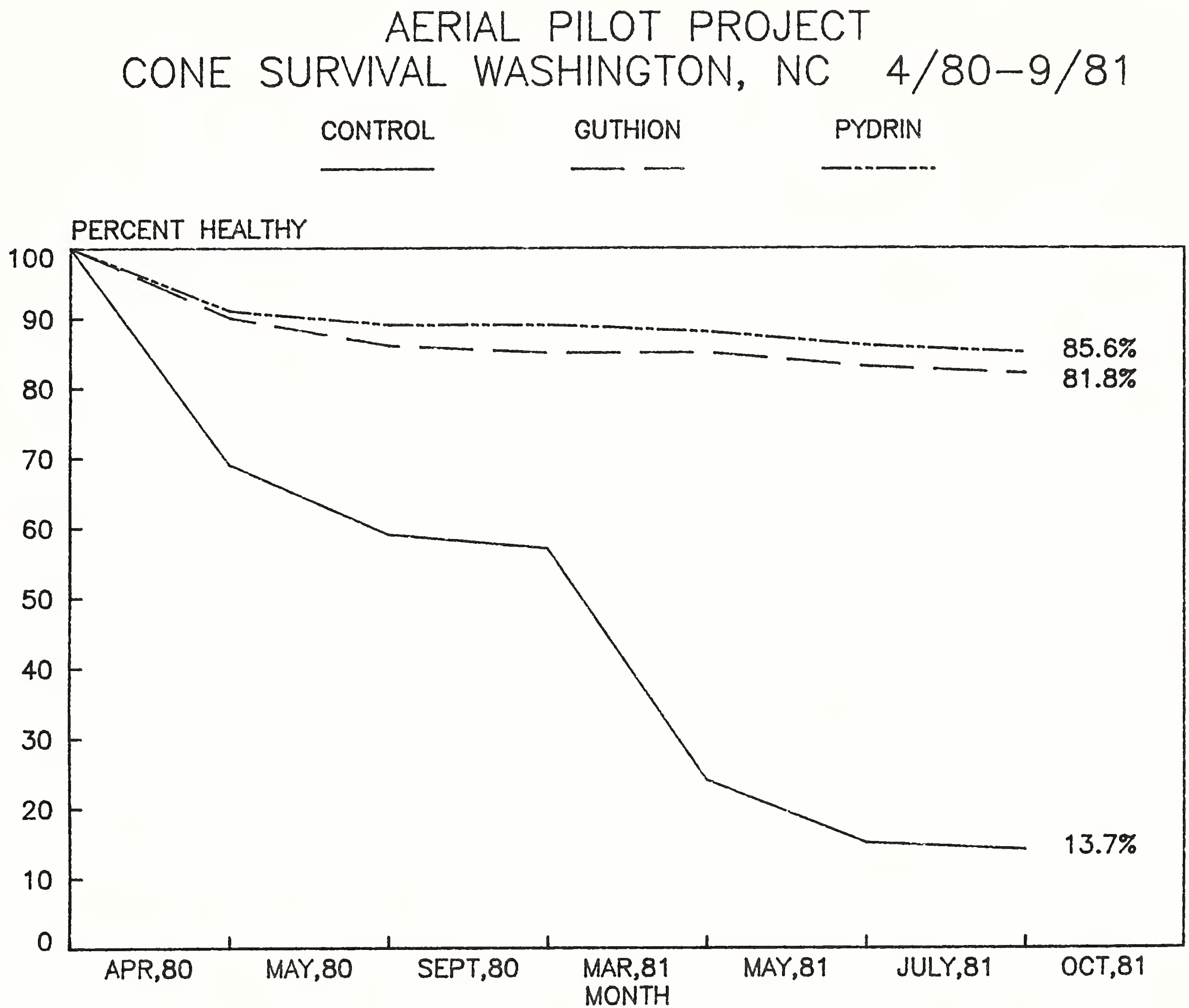
Spray Assessment

No spray deposit data was collected during the 1981 spraying season.

Table 8
Aerial Pilot Project
Weyerhaeuser Co., Wash., N.C.
1981 Loblolly Cone Crop Life Table

				Damaged							
Observation Dates	Structure Stage	Healthy		Unknown		*Dioryctria disclusa*		Other Dioryctria		Malformed	
		#	%	#	%	#	%	#	%	#	%
Untreated Area											
4/80	flower initiation	2232	100	-	-	-	-	-	-	-	-
5/80	conelet	1542	69.1	176	7.9	514	23.0	-	-	-	-
9/80	conelet	1328	59.5	339	15.2	555	24.9	10	0.4	-	-
3/81	cone	1277	57.2	388	17.5	555	24.9	10	0.4	-	-
5/81	cone	541	24.3	407	18.2	1274	57.1	10	0.4	-	-
7/81	cone	331	14.8	414	18.6	1399	62.7	81	3.6	7	0.3
9/81-harvest		1/ 305a	13.7	418a	18.7	1399	62.7	96a	4.3	14	0.6
Pydrin .75 lbs. AI/AC											
4/80	flower initiation	2078	100	-	-	-	-	-	-	-	-
5/80	conelets	1884	90.7	194	9.3	-	-	-	-	-	-
9/80	conelets	1859	89.5	219	10.5	-	-	-	-	-	-
3/81	cones	1853	89.2	225	10.8	-	-	-	-	-	-
5/81	cones	1826	87.9	251	12.1	-	-	-	-	-	-
7/81	cones	1791	86.2	259	12.5	-	-	16	0.8	12	0.5
9/81-harvest		1778b	85.6	264b	12.6	-	-	18b	0.9	18	0.9
Guthion 3 lbs. AI/AC											
4/80	flower initiation	2055	100	-	-	-	-	-	-	-	-
5/80	conelets	1841	89.6	214	10.4	-	-	-	-	-	-
9/80	conelets	1763	85.8	292	14.2	-	-	-	-	-	-
3/81	cones	1756	85.5	299	14.5	-	-	-	-	-	-
5/81	cones	1738	84.6	317	15.4	-	-	-	-	-	-
7/81	cones	1711	83.3	327	15.9	-	-	13	0.6	4	0.2
9/81-harvest		1680b	81.8	337b	16.4	-	-	33b	1.6	5	0.2

1/ Numbers (i.e., # healthy at harvest, # damaged by *D. disclusa* at harvest, etc.) followed by the same letter are not significantly different at the 1% level.



AERIAL PILOT PROJECT
CONE SURVIVAL WASHINGTON, NC 4/80–9/81
CONTROL
GUTHION
PYDRIN
PERCENT HEALTHY
100
90
80
70
60
50
40
30
20
10
0
85.6%
81.8%
13.7%
APR,80
MAY,80
SEPT,80
MAR,81
MAY,81
JULY,81
OCT,81
MONTH

Table 9
1981 Loblolly Pine Cone Crop
Weyerhaeuser Seed Orchard, Wash., N.C.

SEED ANALYSIS

Treatment	Avg. Seed Potential Per Cone	Sound Seed #	Sound Seed %	1st Year Aborted Seed #	1st Year Aborted Seed %	2nd Year Aborted Seed #	2nd Year Aborted Seed %	Empty Seed #	Empty Seed %	Misc. Damaged Seed #	Misc. Damaged Seed %
Untreated	205	63a [1/]	30.8	95a	46.3	15a	7.3	26a	12.7	6a	2.9
Guthion	218	132b	60.6	67b	30.7	2b	0.9	13a	6.0	4a	1.8
Pydrin	205	122b	59.5	62b	30.3	0b	-	21a	10.2	0b	-

1/ Numbers followed by the same letter are not significantly different at the 1% level.

Pesticide Monitoring

Pydrin residues on the foliage in 1981 ranged from 22.8 ppm to 352.8 ppm (Table 7). Guthion residues ranged from 66-194 ppm. Soil residue samples collected from under the canopy with the duff removed in the Guthion area ranged from .024-.73 ppm. There were no residues detected in the Pydrin soil samples collected under the canopy. Soil residue samples collected between rows with the duff removed ranged from .013-.32 ppm of Guthion while in the Pydrin area no residues were detected.

No residues were detected in any of the sediment samples collected from the drainage at the western end of the spray block except for a sample collected on 7/7/81 which showed a trace of Pydrin. Pydrin residues in the water samples collected ranged from none to just a trace. Guthion residues in the water samples collected ranged from none to 98 ppb.

DISCUSSION

The overall objective of this pilot study was to collect adequate data including efficacy, spray assessment, and pesticide monitoring data to support registration of Pydrin and Guthion when applied aerially. This objective was met and both pesticides were given EPA registration.

Based on the life table approach an orchard efficiency table (Table 10) was developed which tracks the entire crop from flower initiation through cone maturity, seed extraction, and finally to numbers of sound seed actually produced. The number of sound seed actually produced divided by the number of seed that potentially could have been produced is called orchard efficiency. In this pilot project, the untreated area had an orchard efficiency of 4.2 percent as compared to 50.9 percent and 49.5 percent in the Pydrin and Guthion areas, respectively.

The primary cause of flower and cone mortality in the untreated area during 1980 and 1981 was damage from the webbing coneworm. At the beginning of the project, little was known about the timing of pesticides to minimize damage from the webbing coneworm. The Guthion label calls for the first application to be within 30 days of flower closure. Based upon the known biology of the pest this spray date was felt to be too late for effective control. Entomologists (FPM and SEFES) recommended to other industry orchards that in 1980 they spray within two weeks of flower closure. For this study we sprayed when approximately one-half of the flowers had closed. This later was determined to be six days after peak pollen flight as determined by pollen trapping. This method proved effective and was adopted southwide in 1981 by orchard managers as the spray timing technique for the webbing coneworm. Unfortunately, most orchards on the Eastern Seaboard reported extensive damage to their loblolly cone crops in 1980, with losses exceeding 75 percent. In 1981, losses on the East Coast were minimal. In 1979, members of the North Carolina Tree Improvement Cooperative harvested 38,693 bushels of loblolly cones, compared to 15,296 in 1980. During 1981, the total rose to 64,811 bushels, with most orchards employing the new spray timing method for _D. disclusa_.

Table 10
Seed Orchard Efficiency Table of 1981
Cone Crop Comparing Untreated, Pydrin
and Guthion Treated Blocks
Weyerhaeuser Seed Orchard, Washington, N.C.

Stage	Check # Per Stage	Check Percent Lost	Check Number Lost	Pydrin # Per Stage	Pydrin Percent Lost	Pydrin Number Lost	Guthion # Per Stage	Guthion Percent Lost	Guthion Number Lost
Flowers	2,232			2,078			2,055		
		40.5	904		10.5	219		14.2	292
1 yr. conelets	1,328			1,859			1,763		
		45.8	1,023		3.9	81		4.0	83
2nd yr. cones	305			1,778			1,680		
Seed Potential 1/ of surviving cones	62,525			364,490			366,240		
		69.0	43,142		40.5	147,618		39.4	144,299
Full Seed	19,383			216,871			221,941		
Orchard Efficiency 2/	4.2%			50.9%			49.5%		

1/ Avg. seed potential per cone for the treatment area as determined by the seed lab: Untreated = 205, Guthion = 218, Pydrin = 205.

2/ Orchard efficiency: Total # of filled seed ÷ (# of initial flowers x seed potential).

Results of the spray assessment and pesticide monitoring document that these pesticides can be applied safely in a seed orchard situation with a helicopter and that these applications resulted in no significant off-site pesticide movement. We also noted that even though up to 9.26 gallons per acre were recovered on the ground line samples in the Guthion area, there was very little movement of the pesticide into the soil. With Pydrin, even less residue moved into the soil.

In both years of this project, secondary sucking insects were found in large numbers on the block of trees sprayed with Pydrin. These included woolly pine scale, *Pseudophilippia quaintancii* Cockerell; pine tortoise scale, *Toumeyella numismatica* (P & McD.); and the loblolly pine mealybug. At the time this report was written little was known about the biology or control of these secondary pests.

BIBLIOGRAPHY

Barry, J. W., P. A. Kenney, L. Barber, R. B. Ekblad, R. J. Dumbauld, J. E. Rafferty, H. W. Flake, and N. A. Overgaard. 1982. Aerial application to southern pine seed orchards. Data report of the Withlacoochee Trials, USDA Forest Service, Forest Pest Management, Asheville Field Office, Asheville, N.C. Report #82-1-23, 99 p.

Bramlett, D. L., E. W. Belcher, Jr., G. L. DeBarr, G. D. Hertell, R. P. Karrfalt, C. W. Lantz, T. Miller, K. D. Ware, and H. O. Yates, III. 1977. Cone analysis of southern pines, A Guide Book, General Technical Report SE-13 p. USDA, Forest Service, Southeastern Forest Experiment Station, Asheville, NC, and Southeastern Area, S&PF, Atlanta, GA.

Debarr, Gary L. and Barber, Larry R. 1975. Mortality factors reducing the 1967-1969 slash pine seed crop in Baker County, Florida--A life table approach. USDA, Forest Service, Southeastern Forest Experiment Station, Asheville, NC, Research Paper SE-131.